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Attorney GPB  
TC GPBDocket Number 199-0438  
Classification 04.05.10

Short Descriptive Title of Invention: Anti-Rollover Stability Control				CPSC	
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<b>COMPLETE THE FOLLOWING AND THE ATTACHED PAGES</b>					
1. What do you consider to be the new technology of the invention? Supplement current IVD systems with roll rate sensor for roll instability identification and control.					
2. Identify the purpose/function of the new technology(s) of the invention and advantages over prior technology. Active control of roll instability. Brake force applied on laden wheel(s) reduces tire lateral force(s) and therefore reduces vehicle overturning moment and reduces occurrence of vehicle roll over.					
3. Identify the closest technology, if any, of which you are aware. Provide copies, if available. IVD - Stability Control.					

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PAGE 7/29 \* RCVD AT 8/10/2005 9:12:42 AM [Eastern Daylight Time] \* SVR:USPTO-EFXXF-6/27 \* DNIS:2738300 \* CSID:248 2239522 \* DURATION (mm:ss):06:58

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4. Identify first dated record(s) of invention.		5. Date a working model, device or process was or will be completed.	
6. If the invention will be released for production, identify model and year.		7. Identify a government agreement, partnership, consortium, or other company involved with conception or first building of the invention, if any.	
8. If disclosed to non-Company personnel, identify recipient and date.			
9. Advanced Project No., if any.	10. Name of related Technology Council, if any.	11. Name of related Technology Forum, if any.	

**DESCRIPTION OF THE INVENTION (USE INK)**

Provide a written description of the invention, preferably with reference to attached prints, sketches, photos, components, reports, etc. The description should provide a clear, complete understanding of the invention, including its operation and environment. All attachments must be signed by the inventor(s), dated and witnessed.

Sensors, including rotation rate along any combination of axis and/or acceleration along any combination of axis and/or any combination of speed sensors and/or any form of GPS information is/are used to identify a vehicle instability or tendency towards instability in the roll plane. This information is then used to take action in reducing the overturning moment generated by tire lateral forces. This action can be implemented through any means or combination of: modifying the longitudinal force of the tire through inducing a rotational torque on the wheel and/or direct modification of the tire lateral force through actively modifying the tire steer or camber angle and/or modifying the tire normal force through suspension control.

One such realization of the invention includes the augmentation of an existing IVD system with a roll rate sensor. This roll rate sensor is used in conjunction with the existing IVD sensor set and new software strategies to identify vehicle roll and roll instability. New software strategies then determine appropriate brake forces to apply in response to vehicle roll over instability. Existing IVD hydraulics are used to build brake forces on the laden wheels to reduce tire lateral forces. This tire lateral force reduction induces a compensating torque in the roll plane which reduces the resultant vehicle overturning moment and facilitates increased vehicle robustness to roll over.

Please see attachments for further detail.

**DESCRIPTION OF THE INVENTION (cont'd.)**

See Attached

**LIST ALL ATTACHMENTS:**

Diagram of System Principal, Inertial Sensor Offset Compensation and Filtering, Chassis Roll Angle Estimation and Compensation, Relative Roll Calculation, Feedback and Desired Pressure Calculation.

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Tom Allen Brown 3/30/99  
Signature of Inventor Date

David E. Leonard 3/30/99  
Signature of Witness Date

Douglas Scott Rhoads 3/30/99  
Signature of Inventor Date

Ray M. Velt 3/30/99  
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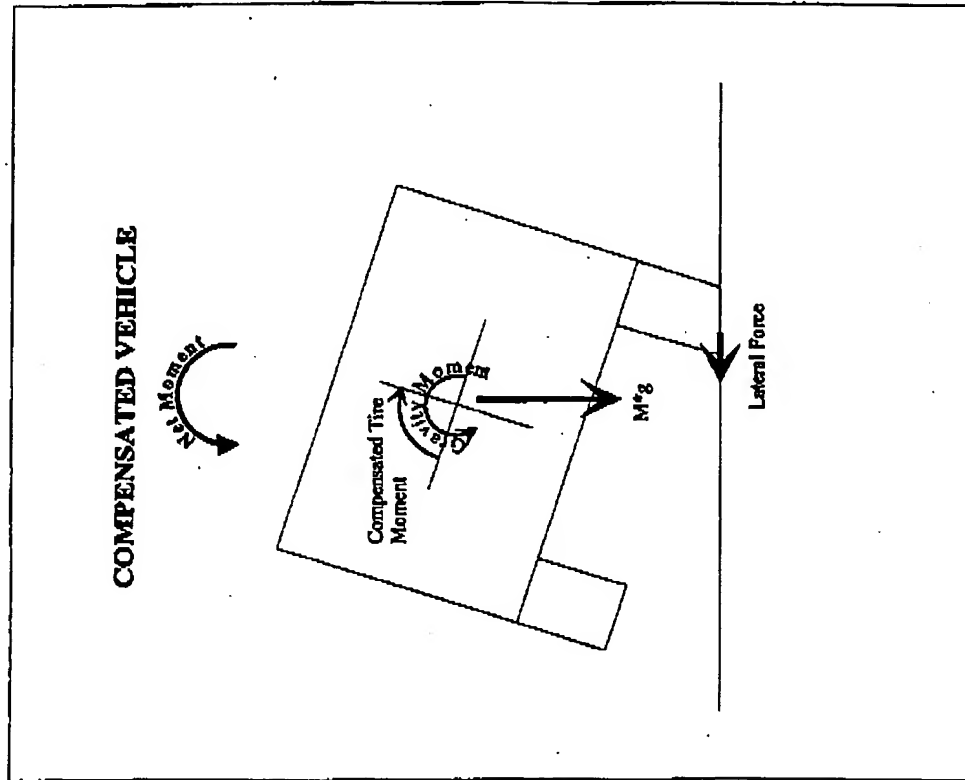
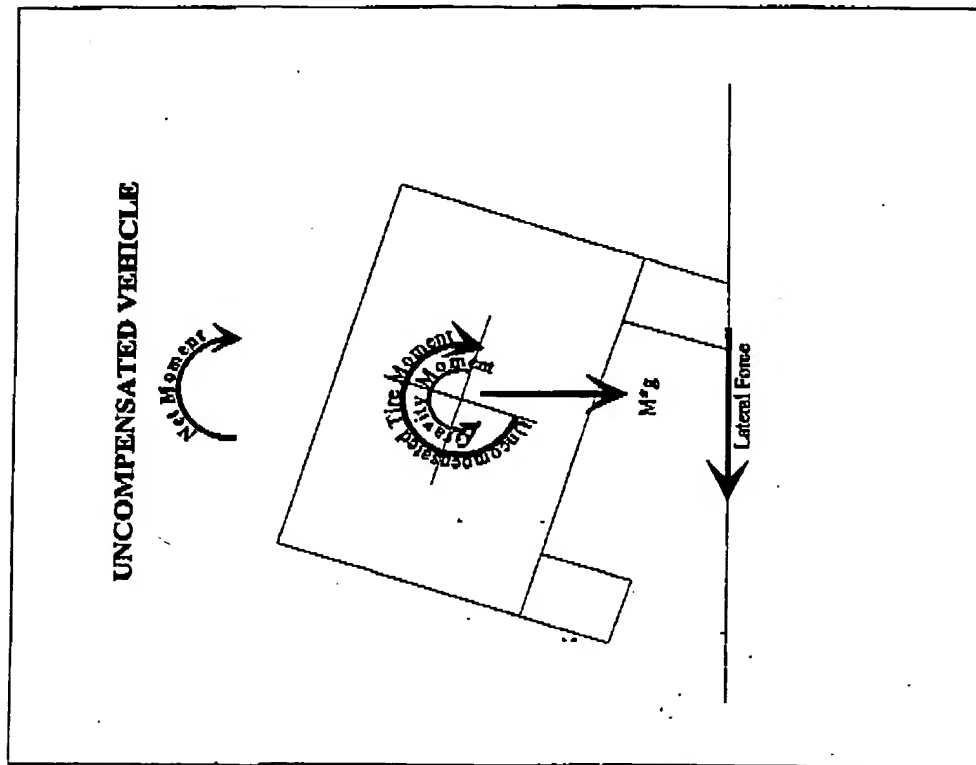
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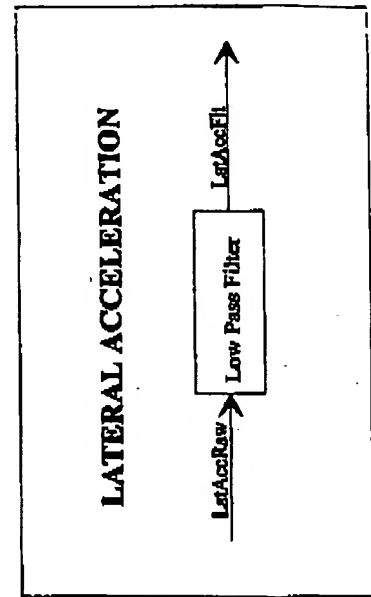
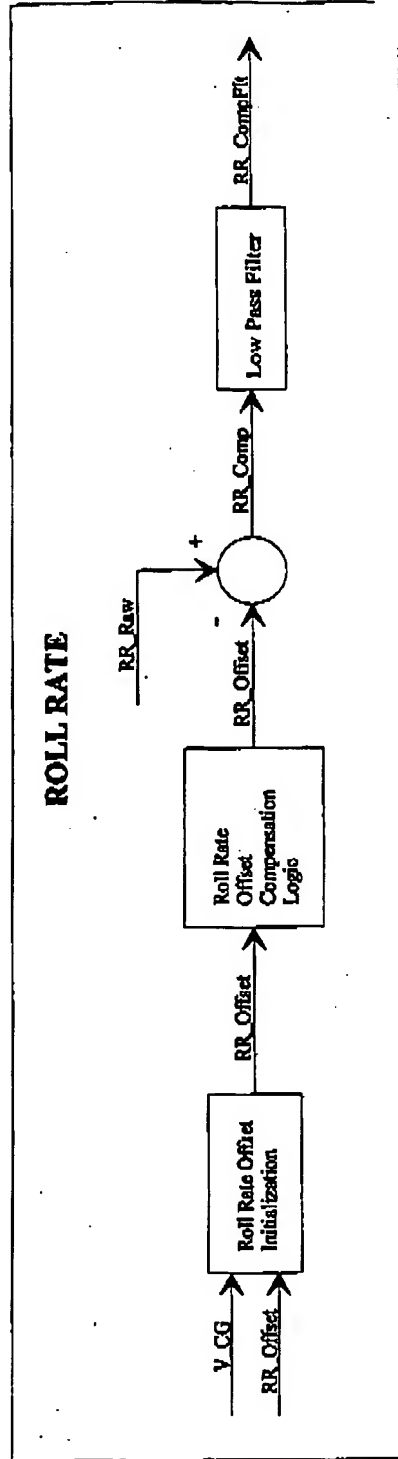
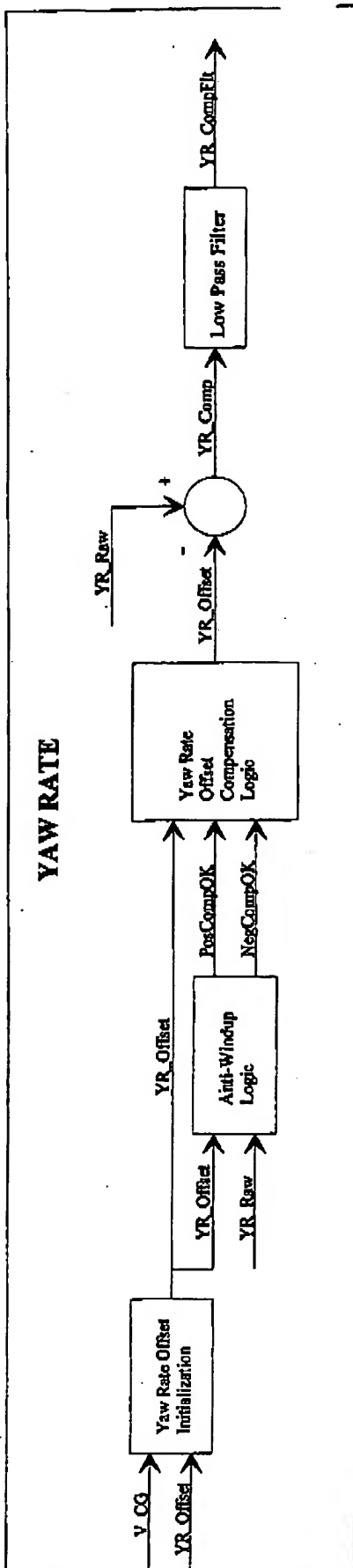
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ROLL STABILITY CONTROL  
DIAGRAM OF SYSTEM PRINCIPAL



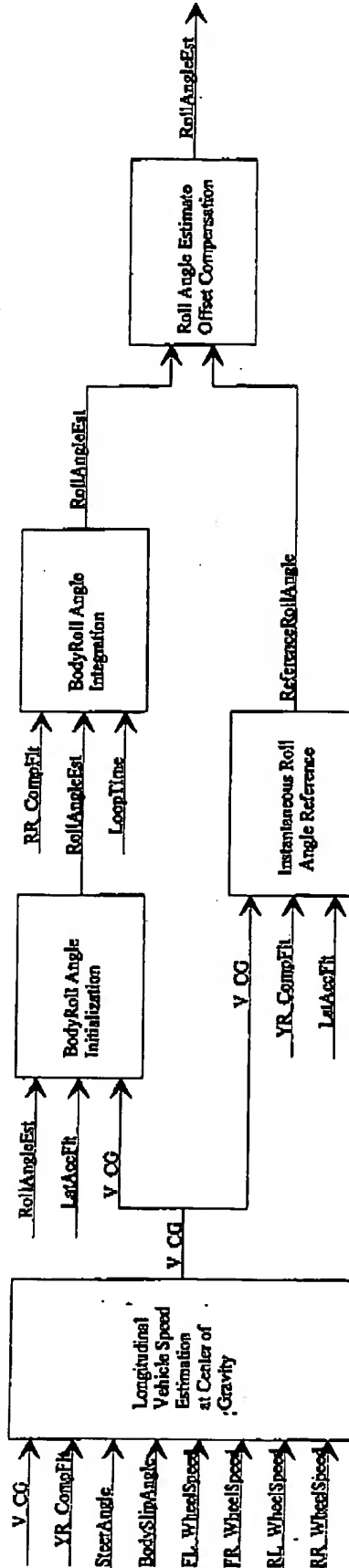
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# ROLL STABILITY CONTROL INERTIAL SENSOR OFFSET COMPENSATION AND FILTERING



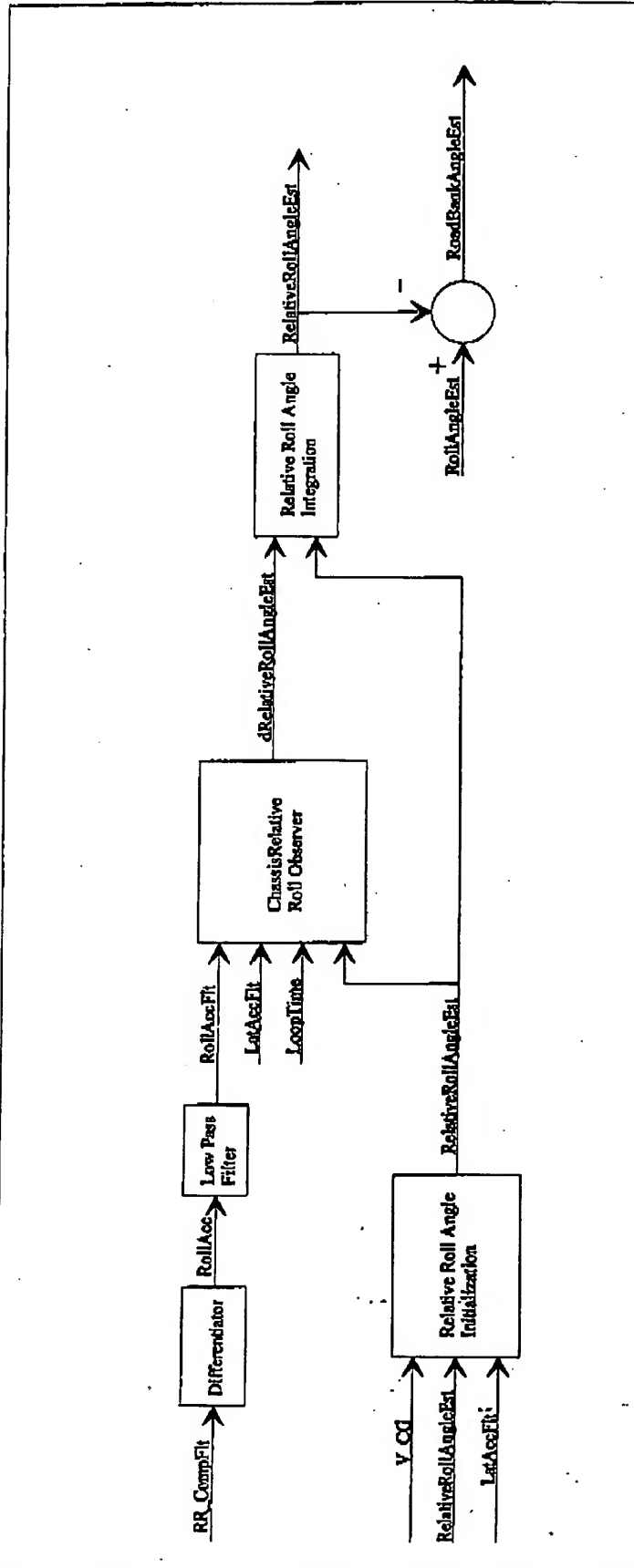
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# ROLL STABILITY CONTROL CHASSIS ROLL ANGLE ESTIMATION AND COMPENSATION



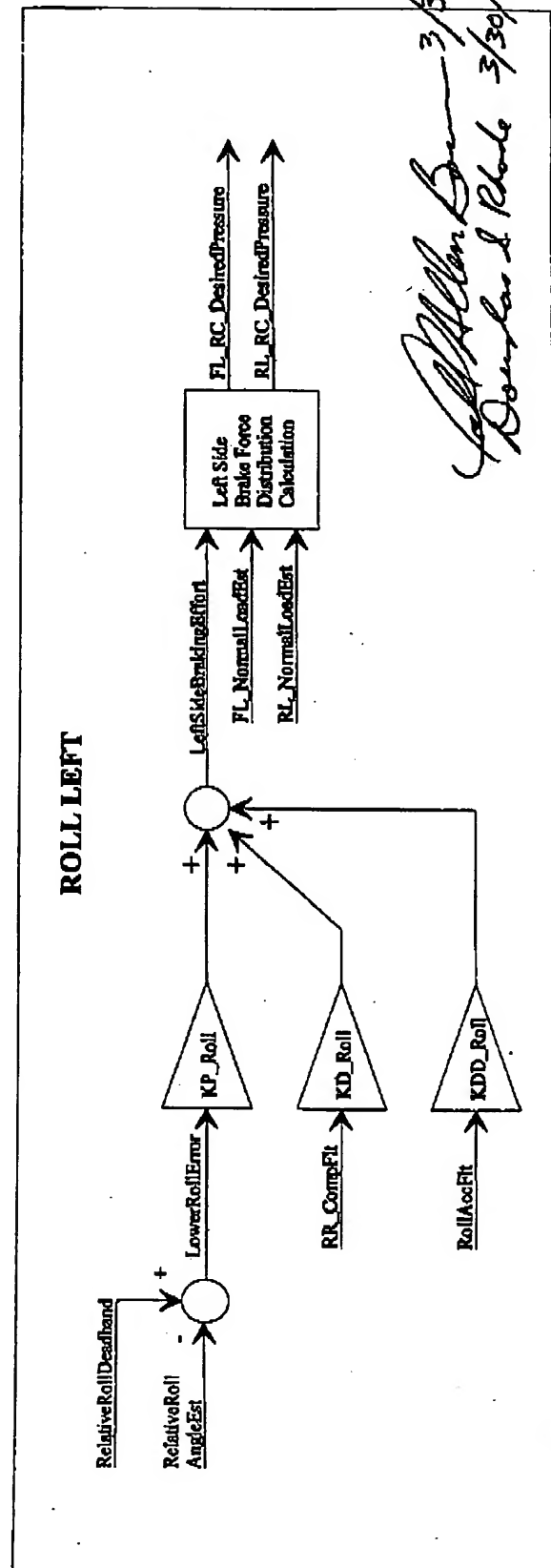
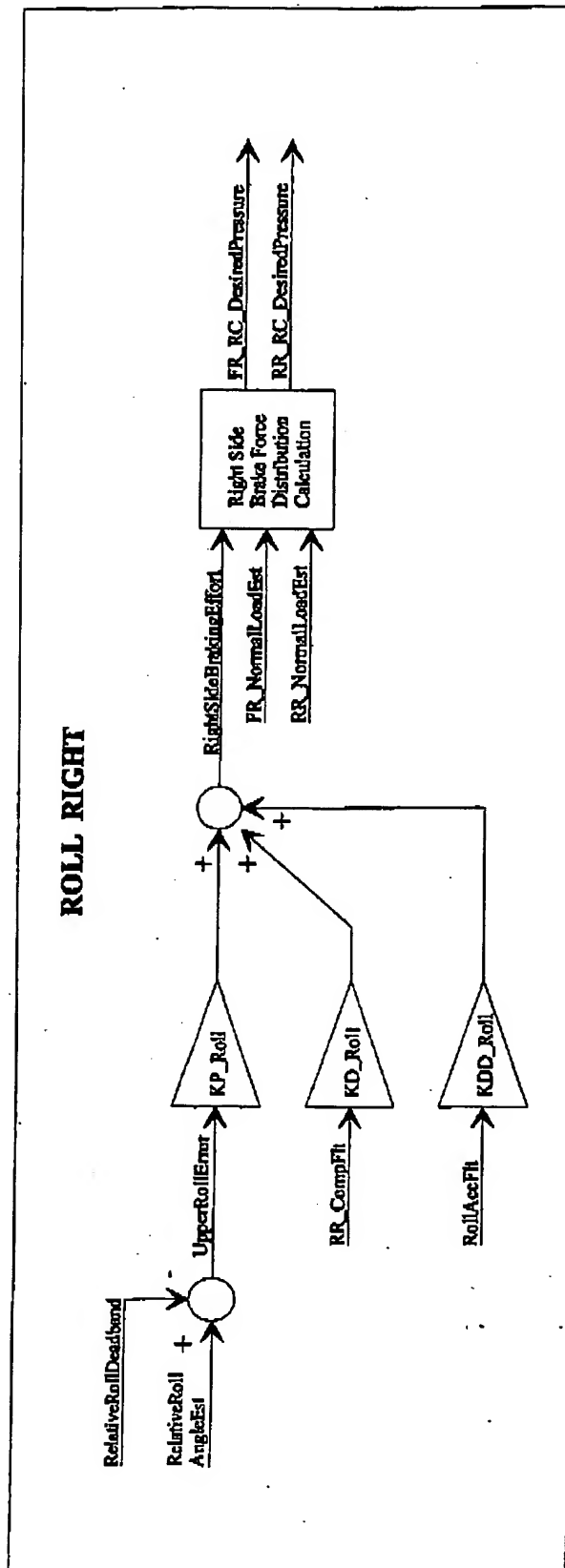
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ROLL STABILITY CONTROL  
RELATIVE ROLL CALCULATION



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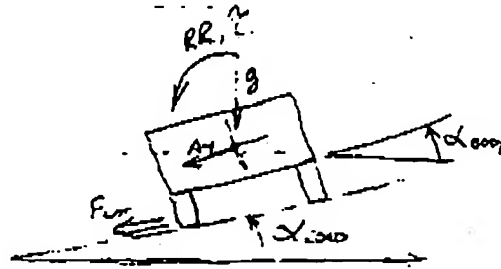
# ROLL STABILITY CONTROL CALCULATION OF SYSTEM FEEDBACK





IDENTIFICATION

990327.



$$A_y = \frac{F_{\text{net}}}{M}$$

(1)

$$X_{\text{com}} = X_{\text{BODY}} - X_{\text{ROAD}};$$

$$\dot{X}_{\text{com}} = \dot{X}_{\text{BODY}} - \dot{X}_{\text{ROAD}};$$

$$\ddot{X}_{\text{com}} =$$

$$\ddot{X}_{\text{BODY}} = \text{MEASURED};$$

$$A_y = \text{MEASURED};$$

$$\ddot{X}_{\text{BODY}} = \text{ESTIMATED};$$

$$T_{\text{ROAD}} = -K_{\text{com}} * X_{\text{com}} - C_{\text{com}} * \dot{X}_{\text{com}};$$

$$\Sigma F = T_{\text{ROAD}} + A_y * M * H_{\text{CG}} = T_{\text{com}} * \ddot{X}_{\text{com}};$$

$$-K_{\text{com}} * X_{\text{com}} - C_{\text{com}} * \dot{X}_{\text{com}} - A_y * M * H_{\text{CG}} = T_{\text{com}} * \ddot{X}_{\text{com}};$$

$$\ddot{X}_{\text{com}} = \ddot{X}_{\text{com}} \cdot \frac{1}{1 + \frac{C_{\text{com}}}{K_{\text{com}} * \ddot{X}_{\text{com}}}};$$

$$\ddot{X}_{\text{com}} = \frac{\ddot{X}_{\text{com}}}{\text{LOOP TIME}};$$

$$-K_{\text{com}} * (X_{\text{com}} \cdot \frac{1}{\text{LOOP TIME}}) - C_{\text{com}} * \frac{\dot{X}_{\text{com}}}{\text{LOOP TIME}} - A_y * M * H_{\text{CG}} = T_{\text{com}} * \ddot{X}_{\text{com}};$$

$$-K_{\text{com}} * X_{\text{com}} \cdot \frac{1}{\text{LOOP TIME}} - \left( \frac{C_{\text{com}}}{\text{LOOP TIME}} \right) * \dot{X}_{\text{com}} - A_y * M * H_{\text{CG}} = T_{\text{com}} * \ddot{X}_{\text{com}};$$

$$\ddot{X}_{\text{com}} = \frac{K_{\text{com}} - C_{\text{com}}}{\text{LOOP TIME}} \left( K_{\text{com}} * X_{\text{com}} \cdot \frac{1}{\text{LOOP TIME}} + A_y * M * H_{\text{CG}} + T_{\text{com}} * \ddot{X}_{\text{com}} \right);$$

$$f(X_{\text{com}} > X_{\text{REF}}) \quad \ddot{X}_{\text{com}} = 0 \quad \text{Account For When LIFT *}$$

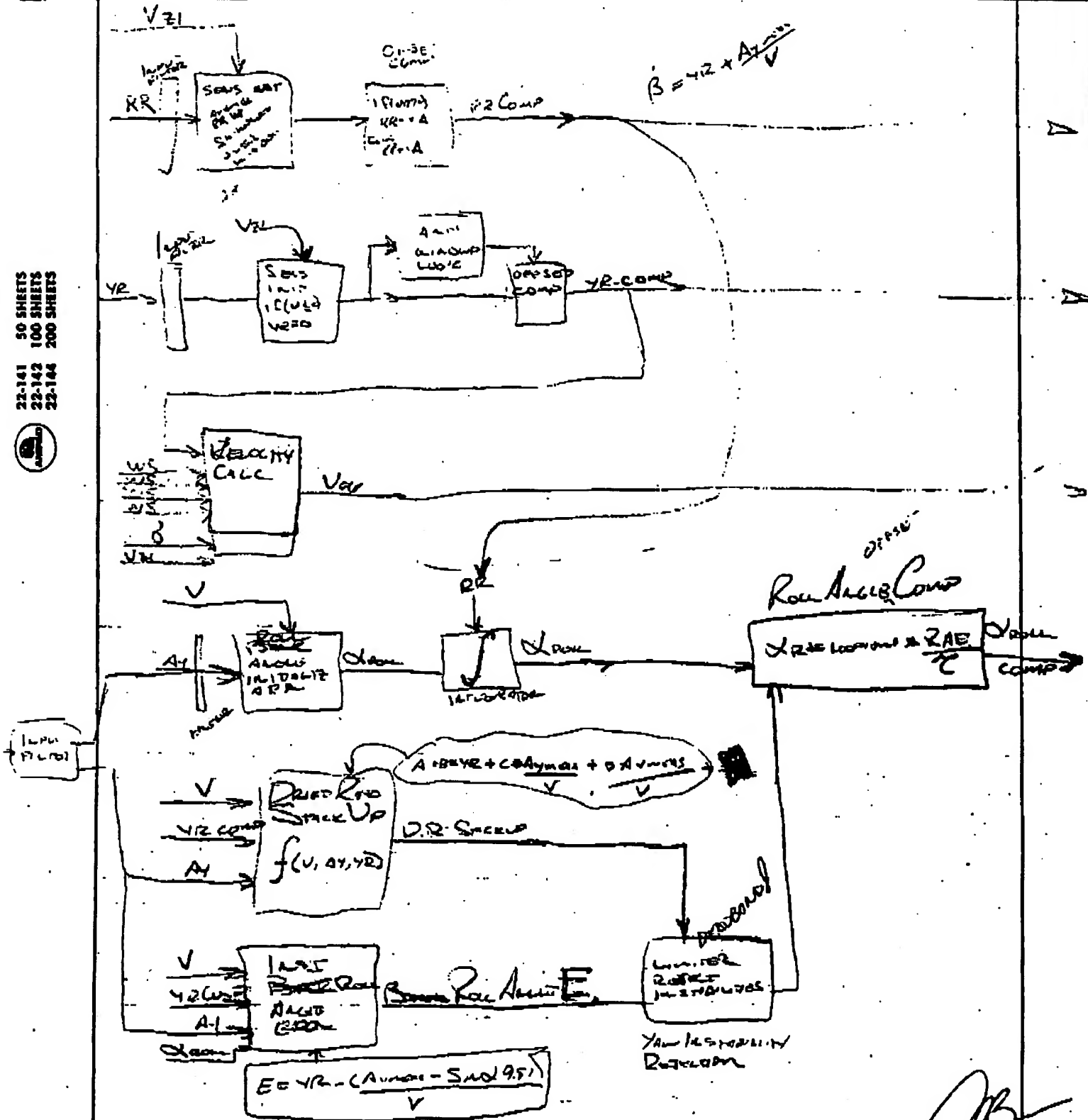
$$X_{\text{com}} = \ddot{X}_{\text{com}};$$

$$X_{\text{ROAD}} = X_{\text{BODY}} - X_{\text{com}};$$

22-141 50 SHEETS  
22-142 100 SHEETS  
22-144 200 SHEETS



22-141 50 SHEETS  
22-142 100 SHEETS  
22-144 200 SHEETS



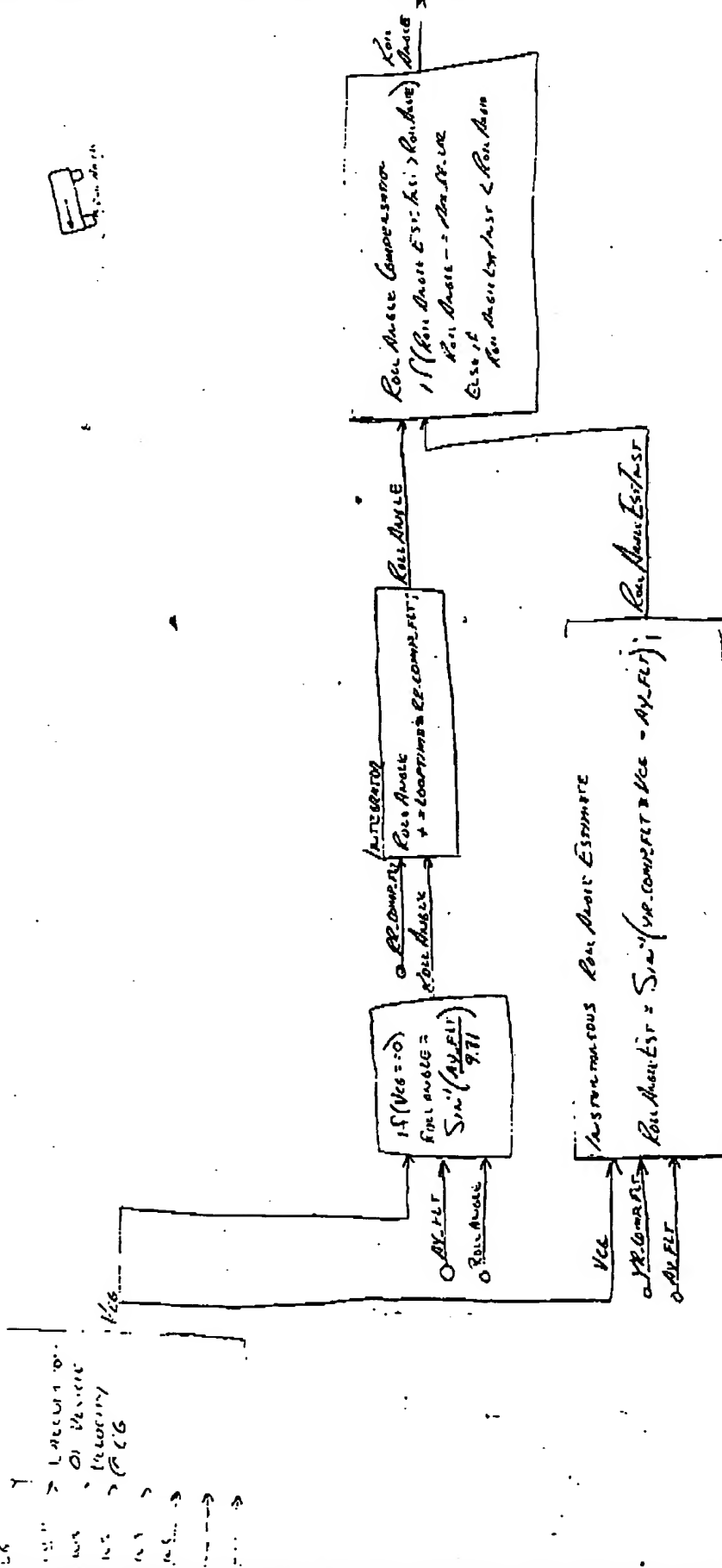
$$\frac{d\beta}{dt} = \frac{A_{Y_{Z2}}}{V} \left( \frac{V}{V} \right) \beta$$

30 MAR 99



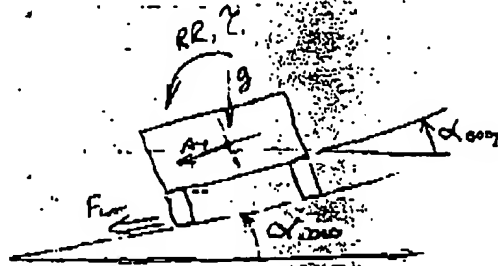


Cross Velocity And Roll Angle Estimation



30 Mar 99

IDENTIFICATION



$$A_y = \frac{F_{\text{net}}}{M}$$

$$\alpha_{\text{com}} = \alpha_{\text{body}} - \alpha_{\text{comp}}$$

$$\alpha_{\text{com}} = \alpha_{\text{body}} - \alpha_{\text{comp}}$$

$$\alpha_{\text{body}} = \text{Measured};$$

$$A_y = \text{Measured};$$

$$\alpha_{\text{com}} = \text{Estimated};$$

$$\tau_{\text{net}} = -K_{\text{com}} \times \alpha_{\text{com}} - C_{\text{com}} \times \dot{\alpha}_{\text{com}}$$

$$\Sigma \tau = \tau_{\text{net}} = A_y \times M \times H_{\text{com}} + \tau_{\text{com}}$$

$$-K_{\text{com}} \times \alpha_{\text{com}} - C_{\text{com}} \times \dot{\alpha}_{\text{com}} - A_y \times M \times H_{\text{com}} = \tau_{\text{com}} \times \alpha_{\text{com}};$$

$$\alpha_{\text{com}} = \alpha_{\text{com}} \times 2 + \alpha_{\text{com}}$$

$$\alpha_{\text{com}} = \frac{d\alpha_{\text{com}}}{dt}$$

$$\text{LoopTime}$$

$$-K_{\text{com}} (\alpha_{\text{com}} \times 2 + \alpha_{\text{com}}) - C_{\text{com}} \times \frac{d\alpha_{\text{com}}}{dt} - A_y \times M \times H_{\text{com}} = \tau_{\text{com}} \times \alpha_{\text{com}};$$

$$-K_{\text{com}} \times \alpha_{\text{com}} \times 2 - (K_{\text{com}} \times \alpha_{\text{com}}) \times \frac{d\alpha_{\text{com}}}{dt} - A_y \times M \times H_{\text{com}} = \tau_{\text{com}} \times \alpha_{\text{com}};$$

$$d\alpha_{\text{com}} = \frac{K_{\text{com}} + C_{\text{com}}}{\text{LoopTime}} \left( K_{\text{com}} \times \alpha_{\text{com}} \times 2 + A_y \times M \times H_{\text{com}} + \tau_{\text{com}} \times \alpha_{\text{com}} \right);$$

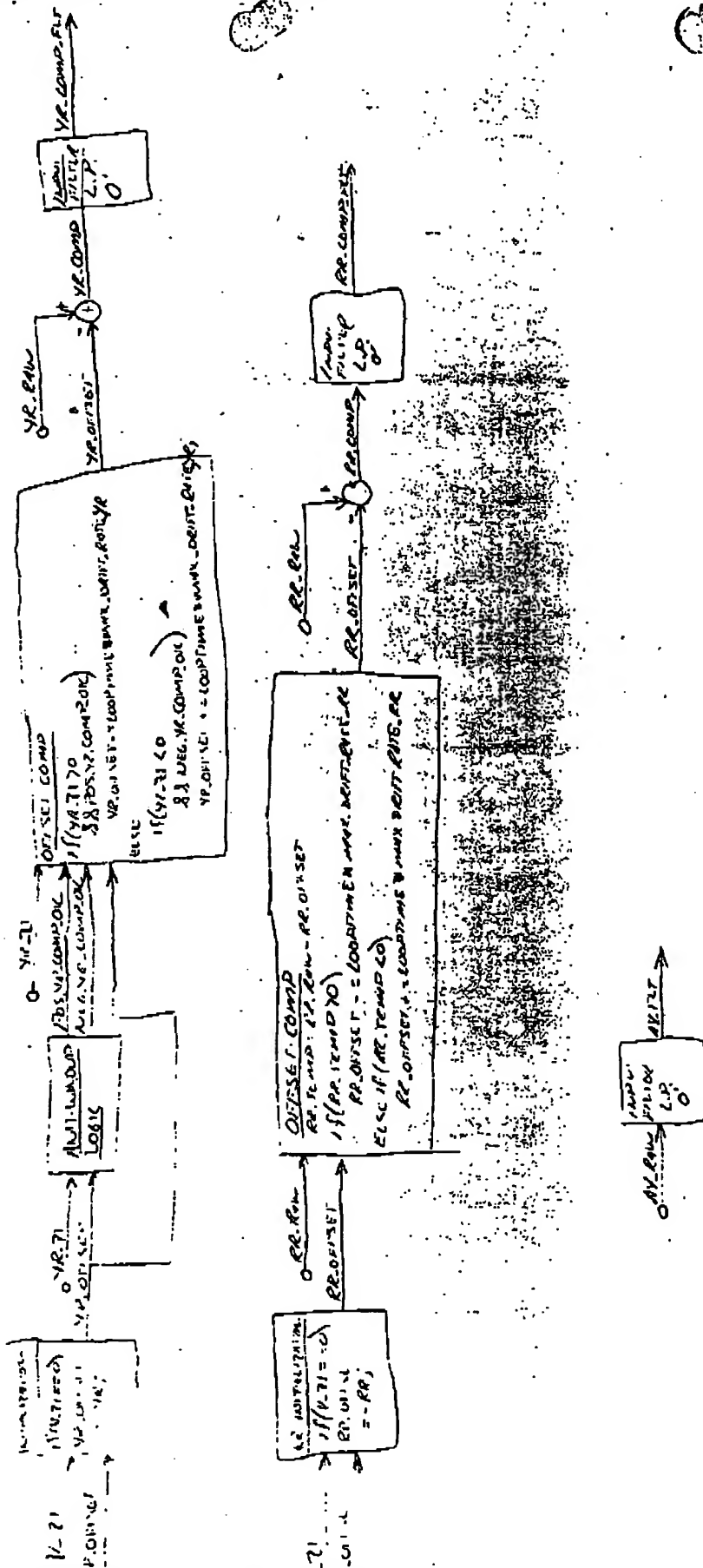
$$\text{If } (\alpha_{\text{com}} > \alpha_{\text{max}}) \quad d\alpha_{\text{com}} = 0;$$

$$\alpha_{\text{com}} = \alpha_{\text{com}};$$

$$\alpha_{\text{com}} = \alpha_{\text{com}} - \alpha_{\text{com}};$$

31 Mar 99





30 June 1991







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